Section 7. Blue Crabs

Introduction

The blue crab, *Callinectes sapidus*, resource is the most valuable commercial and recreational fishery in the Chesapeake Bay (Rugolo et al. 1998). Historically, the resource supported an average harvest of 73 million pound (1968-2004)). Most recently, the three-year average (2002-2004) was approximately 54 million pounds or 26% below the long-term average (CBSAC 2005). In Maryland, the average dockside value of blue crabs over the last three years (2002-2004) was approximately $32 million.

Blue crabs were one of the first species slated for the development of a Chesapeake Bay fishery management plan (FMP). In 1989, the Chesapeake Bay Program (CBP) adopted the Blue Crab FMP. The plan was revised in 1997 and two important groups were formed to address baywide scientific, monitoring and management issues: the Blue Crab Technical Committee and the Bi-State Blue Crab Advisory Committee. These two groups have been addressing the major strategy of the 1997 CBP Blue Crab FMP on stock status, i.e., provide long-term protection for the blue crab stock and maintain a stable stock; establish quantitative targets (such as abundance, biomass, or other indices) and biological reference points. In 2003, Amendment #1 to the 1997 CBP Blue Crab FMP was adopted. The purpose of Amendment #1 was to formally adopt biological reference points for managing the resource; reaffirm strategies to reduce fishing effort; and recognize the importance of biological monitoring, habitat protection and ecosystem processes (Table 1).

Maryland Fisheries Service, in partnership with the Chesapeake Bay Program jurisdictions, has begun the process of developing ecosystem-based fishery management plans (EBFMPs) for five important fishery resources: blue crabs, oysters, alosids (shad & herring), menhaden, and striped bass. The ecosystem-based management approach will include a more comprehensive consideration of the interactions among the target species, predators and prey; the effects of climate and weather; habitat utilization; and the hydrographic and physical parameters that influence the spatial and temporal distribution of species in Chesapeake Bay. Through EBFMPs, CBP jurisdictions will develop management strategies and actions that specifically consider species functions within the ecosystem. A draft EBFMP biological background section for blue crabs is slated for completion by December 2005.

Stock Assessment

The first baywide assessment of blue crabs in Chesapeake Bay was completed in 1997. It concluded that the stock was fully exploited and at average levels of abundance (Rugolo et al. 1998). In 2003, a new, more inclusive stock assessment was proposed and completed October 2005. The most recent blue crab stock assessment made advances in the understanding and appraisal of the following elements: estimates of natural mortality; adjustments in historical landings data based on reporting changes, and the development of a new assessment model. As a result of the reassessment of these elements, the biological reference points (BRPs) used to manage the fishery have been refined. Instead

of using the rate of fishing mortality (F) for the BRPs, which is significantly influenced by the estimate of natural mortality, the historical pattern of exploitation is utilized to estimate reference points. Based on the exploitation fraction, the 2005 stock assessment concluded that the blue crab stock is not overfished nor is overfishing currently occurring. However, the assessment does indicate the stock has been overfished in the past and is still at a relatively low level of abundance and continues to be at risk (Miller et al. 2005).

Stock Status

The 2005 blue crab stock assessment indicates that the blue crab population in Chesapeake Bay is below average levels. Fishery independent surveys indicate that the overall abundance of blue crabs during 2004 was low and similar to the 2002 and 2003 levels. Historic low levels of abundance were reported in 2000 and 2001, and the stock has slightly improved since then. A closer look at the age structure of the blue crab stock reveals that juvenile (age 0) crabs have increased, but the abundance of age 1+ and mature female crabs is still low and needs continued monitoring. The blue crab stock is still at risk for recruitment failure. Additional analyses on the size structure of the population are needed and would improve future updates of the stock assessment.

Although Amendment #1 wasn't formally signed until 2003, the Bay jurisdictions began implementing the biological reference points (BRPs) in 2001. The jurisdictions adopted a threshold fishing mortality rate that preserves 10% of the blue crab spawning potential, relative to an unfished stock, and a minimum stock size threshold. The current overfishing threshold is F=1.0. A threshold is defined as the level that should not be exceeded. The target fishing mortality rate is expected to increase spawning potential from 10% to 20% relative to that of an unfished stock. The target F=0.7. A target is defined as a safe, conservative management level that is always less than the threshold.

A review of the BRPs indicate that blue crab abundance in 2004 was above the threshold but below the level for any additional management actions to be considered. The three-year average of mature female spawning stock abundance was about the same as 2003. The previous three years indicated an increasing trend from the historic low. The three-year average of exploitable biomass (age 1+) has been below the long-term average for ten of the past eleven years. Estimated fishing mortality (F=1.19) increased from 2003 (F=0.8), after three previous years of decreasing mortality rates. However, the estimated F is sensitive to the estimate of natural mortality and conversion rates that change harvest data from pounds to numbers (CBSAC 2005).

Because of the uncertainties associated with calculating F, the 2005 Stock Assessment report recommends a change in the way the stock is assessed. Instead of calculating F, the report recommends using the exploitation fraction (u, the proportion of the vulnerable population that is harvested each year) to characterize the status of the stock. A re-evaluation of exploitation fractions from past data indicates that u has varied between 33% (1991) and 71% (1999). The most recent estimate of u is 50%. The

advantage to using *u* instead of F is that *u* is independent of estimates of natural mortality.

Fishery Statistics

Annual blue crab landings from the Bay have ranged between 40 million to 110 millions pounds, 1945 and 2004 (Figure 1). In general, landings data between 1945 and 1989, are limited to pounds harvested by major gear categories (crab pots, trotlines and Virginia dredge. The crab pot is responsible for the majority of the bay wide crab harvest, landing an average of 68% of the catch, from 1945 to 2002 (MDNR Blue Crab Project). The MDNR Blue Crab Project staff prepared the following section on the fishery:

Over the years the reporting systems have undergone changes in Maryland and Virginia. In Maryland, commercial harvest records can be separated into three reporting periods.

1945-1980. Prior to 1981, MDNR employed a self-reporting system in which harvesters reported directly to the state. Data for this period are available by month and gear. Raw data, i.e., harvester reporting forms, are no longer available – all information is held in computer files.

1981-1993. Concerns over deficiencies in the self-reporting system lead to a change in reporting in 1981. From 1981 to 1993, MDNR employed a statistical survey to estimate total landings. Commercial harvesters were classified according to license type. A sample of volunteer harvesters was selected from each category every month to provide detailed removals information. Total removals were estimated by expanding data to the total number of crabbers within each license category. Expansions assume that people with a given license type that did not report, fished at a similar level to those that did report.1994 to present. In 1994, MD DNR implemented a mandatory reporting program. Removals data are collected by month, license type, gear, area fished, effort and market category. Concerns over misreporting are addressed by the continued use of the expansion program in order to calculate total removals for the 1981-1993 period.

As a result of the numerous changes to the reporting systems Fogarty et al. (2004) applied a multivariate time series analysis to assess the impact of reporting changes. As a result of these analyses, bay wide removals were adjusted to compensate for the changes in reporting systems. The adjusted removals were used in the 2005 Chesapeake Bay blue crab stock assessment (Miller et al.2005). Despite adjustments to the commercial removals data, landings from Maryland and Virginia are relatively robust beginning in 1990, and enable the tracking of landings by sex and life stage. Mature female crabs make up the majority of bay wide landings. Due to life history of the blue crab, the harvest by sex varies greatly between Maryland and Virginia. The majority of Virginia harvest is composed of mature females because of the migration of mature females to higher salinity waters (lower Bay) for spawning and consequent development of eggs and larvae. Mature females make up, on average, 70% of Virginia's landings. Conversely, the majority of Maryland landings are male, although there has been an increasing trend in the harvest of mature females since 1990.

The soft and peeler crab portion of the commercial harvest is a small percentage of the total harvest by weight. Since these crabs have a smaller minimum size compared to hard crabs, the total number of soft and peeler crabs harvested is a more significant portion of the total removals. In 2004, soft and peeler crabs made up 4.5% of the weight of the harvest but accounted for 12.5 % of the total number of individuals harvested. From 1990 to 2003 the soft and peeler crab harvest has ranged from 1.7 to 4.0 million pounds with no specific trends.

The crab pot is the main gear used in Virginia and catches nearly 100% of the total male crab harvest and 84% of the total mature female harvest. The dredge fishery, which occurs in the winter, makes up the other 15% of the mature female harvest. Crab pots are also responsible for the majority of the harvest in Maryland, accounting for 82% of mature females and 53% of males harvest. Because pots are prohibited in the MD tributaries, trotlines harvest 45% of the males and 18% of mature females.

Despite several surveys that have been conducted over the years, recreational blue crab harvest remains largely unquantified. Maryland recreational estimates range from 11.5 million pounds in 1990 (Stagg et. al. 1992), approximately 25% of the commercial harvest, to 41 million pounds in 1983 (MRFSS) approximately 82% of the commercial harvest. The most recent studies in 2001 and 2002 estimated the number of crabs harvest by recreational crabbers were 5 million and 3.2 million individuals (Ashford, et. al. 2002) which would have been 7% of commercial landings in 2001 and 5% in 2002.

Both Maryland and Virginia require the placement of cull rings in pots to reduce the mortality of undersize crabs. In Maryland the harvest of sponge crabs is prohibited and in Virginia, all dark phase sponge crabs must be returned to the water. There is little harvest of blue crabs by other commercial fishing gear. Pound nets are responsible for the largest amount of crab bycatch. In Maryland, a regulation allowing for the harvest of 2 bushels of crab per day from pound nets, was recently implemented. This should help to quantify the amount of crabs harvested as bycatch.

Research

The Chesapeake Bay Stock Assessment Committee (CBSAC) has funded a number of blue crab research projects over the past few years. These projects include the mechanisms and routes of migrating adult female blue crabs to the spawning grounds; tagging studies to estimate mortality rates and improve stock assessments; ageing methods; an integrated program of basic biology, hatchery technologies and the potential for replenishing stocks; natural mortality of juvenile blue crabs by finfish in SAV beds; growth and recruitment rates of juvenile crabs; and harvest and effort from MD commercial blue crab fishery. The results from these studies will be incorporated into the new EBFMP under development for blue crabs.

References

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Figure 1. Reported bay wide blue crab harvest in pounds from Maryland & Virginia, 1945-2003 (Uncorrected for changes in reporting methods. The solid line is the time series average).

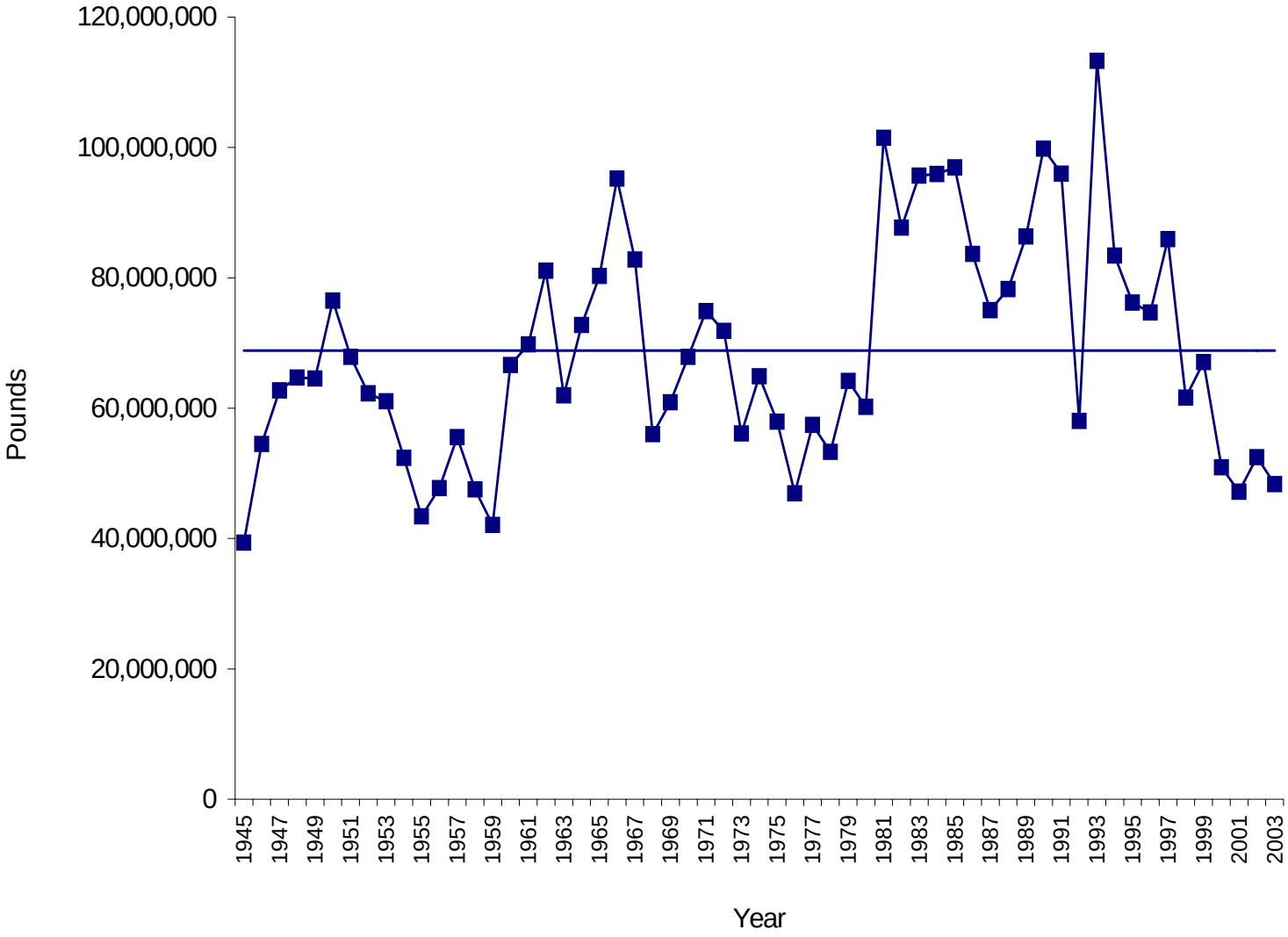

Table 7. 1. 2003 Chesapeake Bay Program Blue Crab Fishery Management Plan Amendment (10/05)

Problem Area	Action	Date	Comments
Stock Status Strategy Chesapeake Bay stock has stabilized at historically low levels but continues to be at risk for recruitment failure.	Action 1 CBP jurisdictions will adopt a threshold fishing mortality rate that preserves 10% of the blue crab spawning potential, relative to an unfished stock, and a minimum stock size threshold.	Began in 2001; formally adopted in 2003	The current overfishing threshold is f=1.0. Estimates from the winter dredge survey indicate that F was above the over-fishing threshold. However, estimates from the length-based method indicate F was below the threshold. There is uncertainty about the appropriate natural mortality rate & conversion rates for changing harvest data from pounds to numbers. The 2005 Stock Assessment recommends using the exploitation fraction (the proportion of the vulnerable population that is harvested each year) instead of F for evaluating BRPs.
	Action 2 CBP jurisdictions will adopt a target fishing mortality of F_{20}, which if achieved, will increase the blue crab spawning potential from 10% to 20% relative to that of an unfished stock.	Began in 2001; formally adopted in 2003	The current target is F=0.7. Both methods of estimating F conclude that F was above the target in 2004.
	Action 3 CBP jurisdictions will develop control rules based on the biological reference points (BRPs) for managing the blue crab resource.	2003	A control rule graph has been developed. Refer to the latest CBSAC Blue Crab Advisory Report (June 2005). The 2005 BC stock assessment has recommended the development of a decision rule that delineates what steps will be taken if the estimated BRPs are beyond the target & threshold.
	Action 4 CBP jurisdictions will utilize the results of fishery-independent surveys to determine stock status.	On going	Abundance data from 2004 remains low but similar to the 2002 and 2003 estimates. Low stock levels continue to create a risk of recruitment failure. The four surveys utilized to determine stock status include the VA Trawl Survey, MD Summer Crab Trawl Survey, Calvert Cliffs Crab Pot Survey and Winter Dredge Survey. The Zooplankton Monitoring Survey provides data for

			evaluating trends in blue crab larval abundance.
Fishing Effort Strategy CBP jurisdictions will adjust fishing effort to achieve the adopted BRPs.	Action 5 CBP jurisdictions will reduce the exploitation rate of legal-sized blue crabs to meet the target BRPs.	Began in 2001; continue	Methods to achieve this objective may include time limits seasons, gear restrictions, catch limits, and/or other methods as necessary and appropriate. The 2004 baywide harvest was approximately 60 million pounds and represents 25% increase from 2003.
Monitoring Strategy CBP jurisdictions will collect fishery - dependent and fishery-independent data on blue crab resources.	Action 6 CBP jurisdictions will continue to monitor blue crab resources in the bay and work towards developing a baywide monitoring approach	On going	Where possible CBP jurisdictions will increase their understanding of the role of the blue crab in the food web of the bay. There are several multispecies monitoring and assessment programs underway.
Habitat Strategy CBP jurisdictions will identify and protect critical blue crab habitat.	Action 7 MD and VA will consider designating additional sanctuary areas to protect blue crab habitat based on new research data.	Continue	Va has designated areas that are closed to crab harvest. Beds of submerged aquatic vegetations (SAV) provide essential habitat for blue crabs..
	Action 8 CBP jurisdictions will continue to protect SAV in potential, post-larval settlement areas.	Continue	Sav beds in near shore habitats provide essential habitat for blue crabs, especially during their post larval and juvenile stages.
	Action 9 CBP jurisdictions will restore and protect SAV in the Chesapeake Bay to achieve the new goal of 185,000 acres by 2010.	Continue	Necessary actions have been identified by CBP jurisdictions to achieve this goal, including the attainment of water quality in shallow-water bay grass designated use areas

	Action 10 CBP jurisdictions recognize the value of salt marsh-fringed habitats and will promote the protection and restoration of marsh-fringed shorelines, creeks and coves	Continue	Blue crabs play an important role in the food web of the bay. They are prey for important species of finfish and are predatory on mollusks.
Ecosystem strategy CBP jurisdictions will incorporate information on ecosystem processes relating to blue crabs as it becomes available and utilize the information to determine management actions as necessary .	Action 11 Utilize the guidelines from the Fisheries Ecosystem Plan (FEP) to incorporate multi-species and ecosystem considerations into existing CBP fishery management plans.	Began 2005	An ad hoc plan development team has been assembled and a draft biological background section should be completed by Dec. 2005.
	Action 12 As data becomes available on food web dynamics, adjust fishing mortality rates on the blue crab population to include predator and prey needs.	On-going	Data on fish predation impacts on blue crabs suggest that fish species have a minimal overall influence on crabs inhabiting seagrass beds. This study will continue in 2005 & additional data will enable the modeling of mulitspecies dynamics for SAV habitats in Chesapeake Bay.
	Action 13 Evaluate the impact of non-native crab introductions on the blue crab population and develop recommendations accordingly.	On-going	There is concern over the interaction of blue crabs with non-native species of crabs, which include the green, mitten and Japanese shore crab.

BRP= biological reference points
CBSAC= Chesapeake Bay Stock Assessment Committee
CBP= Chesapeake Bay Program